AD NUMBER

AD923359

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

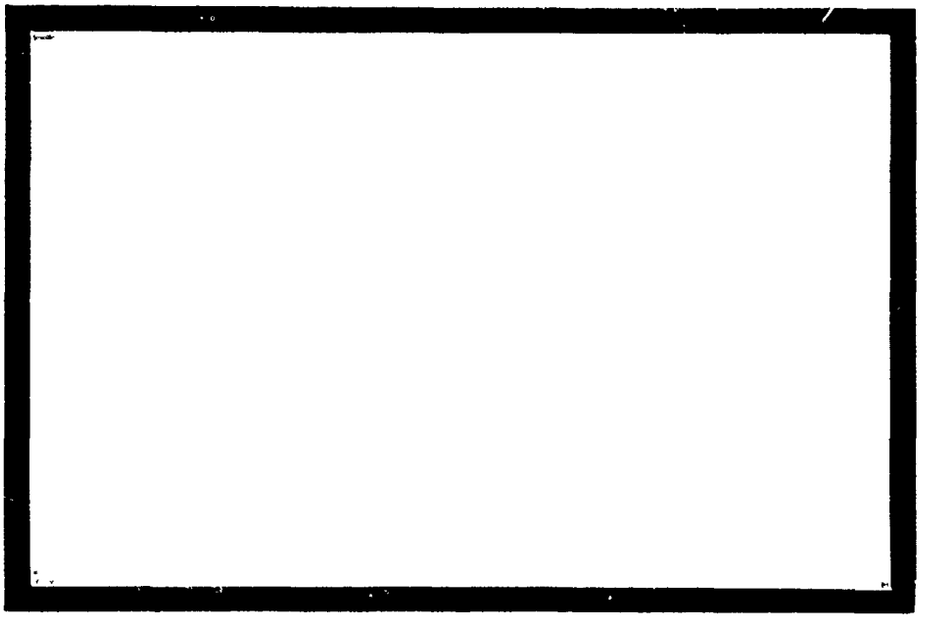
FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Foreign Government Information; APR 1974. Other requests shall be referred to Netherlands Embassy, 4200 Linnean Ave., NW, Washington, DC 20008.

AUTHORITY

Royal Netherlands Embassy, Ambassador's Office, ltr dtd 23 Oct 2009

Rapport TDCK. nr.: 64275



CLASSIFICATIE:

WETENSCHAPPELIJK EN TECHNISCH DOCUMENTATIE- EN

INFORMATIECENTRUM

VOOR DE KRIJGSMACHT

DEN HAAG
NEDERLAND

2000/3000 - 7 - HD 076/67 - 738675* - 166

UNCLASSIFIED

U.D.C.: 551.593:551.594:551.596:016

TDCK-64275

SPECIAL METEOROLOGICAL PHENOMENA.

A BIBLIOGRAPHY.

Period covered: January 1968 - March 1974

Descriptors: Special meteorological phenomena; atmospheric optics; Atmospheric electrics; atmospheric acoustics; bibliographies

Compiled by:
B. Ritsema, Tlt KLU,
Meteorological section,
T.D.C.K.
The Hague, Holland, April 1974

Approved by:
Maj. P.T.L. Olifiers (ret.),
Chief Engineering Sciences Divisic

Netherlands Armed Forces' Scientific and Technical Documentation and Information Centre.

12 49p.

343 950

Special Meteorological Phenomena

ABSTRACT

The bibliography contains about 85 abstracts of articles and reports on special meteorological phenomena, published in scientific periodicals between January 1968 and March 1974.

The bibliography is divided into three chapters:

(1) Optical phenomena in the atmosphere; (2) Electrical phenomena in the atmosphere; (3) Acoustic phenomena in the atmosphere. The second chapter is subdivided into five parts: 2.1 Electrics of fine weather; 2.2 Electrics in clouds and thunderstorms; 2.3 Lightning; 2.4 Ball lightning; 2.5 Aurora.

Within each chapter the material has been arranged chronologically. An index of authors concludes this report.

Photocopies of the articles can be obtained from TDCK.
The reports can be borrowed.

The Hague, April 1974 B.Ritsema.

LIST OF CONTENTS

Chapter 1. Optical Phenomena in the atmosphere

1.1 M 33033 LUCHTSPIEGELINGEN

Raaff, Drs. W.R.

De Zee, 90, (mei 1969), nr. 5, pag. 211-217, 3 fig.

Onder luchtspiegelingen wordt verstaan een optisch verschijnsel in de atmosfeer, dat bestaat uit een afbeelding van een verwijderd object. Men ziet bijvoorbeeld boven een schip aan de horizon het omgekeerde beeld van een schil. De afbeelding kan enkel of meervoudig zijn, rustig of trillend, rechtopstaand of omgekeerd, verticaal vergroot of ingekrompen. Men neemt dus iets waar, dat in gewone normale, omstandigheden niet waargenomen wordt. De oorzaak is dat het licht, afkomstig van het object, een richtingsverandering ondergaat; het wordt in de atmosfeer gebroken.

1.2 N66-32553 ANGULAR DEPENDENCE OF ALBEDO FROM STRATIFORM CLOUDS AS MEASURED BY TIROS IV SCANNING RADIOMETERS

Rabbe, A.

Department of the Geophysical Sciences, The University of Chicago, (June 1966), 19 pag., 8 ref., 19 fig., bibl. TDCK.

Pictures and radiation data from two orbits of TIROS IV have been used in this study to show the anisotropy in the albedo of low stratiform clouds. In order to scan the same clouds from two different directions the authors have used the radiation data when the satellite was in an alternating mode while the floor and wall sensors scanned the earth successively. To express the anisotropy they have used the specular angle, w, and the backscattering angle, o, as parameters. The results show that the albedo is dependent on these two parameters particularly the specular angle.

Optical Phenomena in the atmosphere

1.3 M 32965 EXTINCTION COEFFICIENT MEASUREMENTS ON CLEAR ATMOSPHERES AND THIN CIRRUS CLOUDS

Guttman, A.

Applied Optics, 7, (December 1968), nr. 12, pag. 2377-2381, 8 fig., 2 tab., 7 ref.

An experimental investigation was carried out to determine possible differences in visible light extinction properties of continental and maritime air. Urban, desert, and oceanic atmospheres were probed by means of a stable photodiode radiometer using direct sunlight as the source. No major differences were found for the three locations. Experimental coefficients generally lie slightly below model data, though significantly higher than would be expected from purely molecular scattering. Day-to-day variations of up to 40% were found to be nearly constant over the entire visible spectrum. Results of similar extinction measurements on thin clouds show a slight increase in scattering coefficient in going from 4000 A° to 7000 A° wavelength.

1.4 M 32993 AIRCRAFT MEASUREMENTS OF ALBEDO AND ABSORPTION OF STRATUS CLOUDS, AND SURFACE ALBEDOS

Griggs, M.

Journal of Applied Meteorology, 7, (December 1968), pag. 1012-1017, 4 fig., 1 tab., 16 ref.

Aircraft measurements of the albedo of stratus clouds were made, with the results suggesting, on occasion, that the liquid water content of the cloud has a stronger influence than the cloud thickness on the albedo. The mean cloud absorption was found to be 4% of the incident downward flux. Albedos of other surfaces (ocean, forest, grass, desert, snow and ice) generally agreed with measurements by other authors.

Optical Phenomena in the atmosphere

1.5 M 33877 DIE ENTSTEHUNG DER REGENBOGENTHEORIE

Möller, F.

Meteorol Rundschau, 26, (November/Dezember 1973), nr. 6, pag. 198-208, 8 fig., 41 ref.

Es wird die Entwicklung der Regenbogentheorien bis auf die neueste Zeit beschrieben. Dabei wird besonders Wert gelegt auf die Arbeiten von Theodoricus Teutonicus und Kamâl al Fârisi.

1.6 M 33873 ZUR ENTSTEHUNG DER NEBENLICHTSÄULEN

Lenggenhager, K. von

Zeitschrift für Meteorologie (D R), 23, nr. 11/12, pag. 360-364, 8 fig., 8 ref.

Es wird eine Erklärung gegeben für die seltenen weissen Unternebenlichtsäulen, welche der gleichen Sonnenabstand haben wie eine (nicht obligat) mitanwesende, farbige Nebenuntersonne. Durch die beobachtete grösste Dünne solcher hierfür verantworlicher Eisplättchen werden wohl kräftige Untersonnen reflektiert, jedoch geschehen aus Überlagerungsgründen ihrer wegen ungleicher Dünne unterschiedlich stark gebeugter Strahlen Farbüberlagerungen zu Weisslicht.

1.7 M 33874 ZUM PROBLEM DES WEISSEN HORIZONTALBOGENS

Lenggenhager, K. von

Zeitschrift für Meteorologie (DDR), 23, (1973), nr. 11/12, pag. 365-367, 3 fig., 6 ref.

Es wird eine Erklärung gegeben für die Entstehung des weissen Horizontalkreises. Die herkömmliche Vorstellung von senkrecht mit ihren Längsachen fallenden Eissäulchen mit fallschirmartig oben aufgeklebten Plättchen oder Sternchen würde bei hohem Sonnestande durch Beschattung die Erscheinung nicht zustande kommen lassen. Zudem sprechen die Beobachtungen von Horizontalbogen ohne Nebensonnen eindeutig gegen diese Auffassung.

Optical phenomena in the atmosphere

1.8 M 33831 ZUR FARBARMUT DES SONNENHALOS VON 22° RADIUS

Lenggenhager,K von

Zeitschrift für Meteorologie (DDR), 23, (1972), nr. 5-6, pag. 180-185, 3 fig., 10 ref.

Der Grund für die schwache Leuchtkraft und das "unechte"Spektralrot des Halos liegt einmal an der sehr geringen Zahl der gerade in Minimalablenkungsstellung getroffenen, keine Vorzugslage aufweisenden Eiskriställchen mit für unser Auge unterschwelliger Leuchtkraft; anderseits im ständigen Überlappen von Kriställchen, welche mit ihrer C-Achse nicht genau senkrecht zum Sonneneinfall stehen.
Das Zustandekommen eines Halos durch "kubische", hexagonale Eisprismen konnte auf dem Gipfel des Säntis in unmittelbarer Nähe beobachtet und photographiert werden.

1.9 M 33717 UNCOMMON OPTICAL PHENOMENA AT VENLO 2 MAY 1972

Hattinga Verschure, P.P.

Weather, 28, (July 1973), nr. 7, pag. 300-306, 4 fig., 5 tab., 1 ref.

A great number of rare halo effects were observed in the south-east of Holland (Limburg) during the afternoon of 2 May 1972. The composition of the display resembled that observed from Amsterdam on 2 June 1970 but it was more extensive and at most times very beautifully developed. Moreover the phenomena was visible for a longer time: rare features were continuously seen from 1500 to 1830 GMT.

Optical Phenomena in the atmosphere

1.10 M 33066 ZONES OF THE VISIBILITY OF A NOCTILUCENT CLOUD

Dietze, G.

Tellus, 21, (1969), nr. 3, pag. 436-442, 9 fig., 13 ref.

For a noctilucent cloud (NLC) with its typical features the brightness contrast k of such a cloud against the sky is computed as observed from any point within a circle of more than 800 km. This contrast is compared with the contrast threshold e of the eye. The quotient (k):e is a measure of the degree of visibility. Its distribution over the earth's surface in the vicinity of an NLC at 5 different times during twilight reveals zones of differential visibility.

1.11 M 33095 NOCTICULENT CLOUDS OVER WESTERN EUROPE DURING 1968

Paton, J.

The Meteorological Magazine, 98, (July 1969), nr. 1164, pag. 219-222, 4 fig., 1 tab., 21 ref.

A list of displays of noctilucent clouds observed from Western Europe during 1968 is obtained in 1 table. The first three columns of the table give the night of display, the period of time during which the clouds were observed and details of the cloud forms. The last four columns contain observations from selected stations, giving latitude and longitude, universal time, the max. elevation above the northern horizon and the limiting azimuths.

Optical phenomena in the atmosphere

1.12 M 33825 HINWEISE ZUR BEOBACHTUNG DER LEUCHTENDEN NACHT-WOLKEN

Schröder, W.

Zeitschrift für Meteorologie (DDR), 23, (1972), nr. 1-2, pag. 56-58, 5 ref.

Diese Arbeit enthält Hinweise zur Beobachtung der Leuchtenden Nachtwolken.

1.13 M 33824 UNTERSUCHUNGEN UBER DIE LEUCHTENDEN NACHTWOLKEN

Schröder, W.

Zeitschrift für Meteorologie (DDR), 23, (1972), nr. 1-2, pag. 51-55, 2 tab., 14 ref.

Die deutschen Beobachtungen der Jahre 1885 bis 1941 zeigen folgenden Ergebnisse:
a) die Leuchtenden Nachtwolken treten in Mitteleuropa vornehmlich im Juni-Juli auf,
b) während der Monate September-April lassen sie sich nicht nachweisen;
c) sie wurden bevorzugt vor Mitternacht festgestellt;
d) die Lebensdauer einzelner Wolken kann bis zu einigen Stunden betragen;
e) sie verlagern sich besonders in Richtung SW mit einer durchschittlichen Geschwindigkeit von 48 m/s, jedoch können Einzelgeschwindigkeiten im Wolkenfeld bis zu etwa 150 m/s aufgezeigt werden;
f) ihre Höhe liegt nahezu konstant bei 82 km und
g) es zeigen sich vorzugsweise kürzere Wellenlängen zwischen 8-20 km.

2.1 Electrics of fine weather

2.1.1 M 23648 AIRCRAFT MEASUREMENTS OF FAIR WEATHER ELECTRIC FIELD NOISE WITHIN THE AUSTAUSCH LAYER

Kohl, D.A.

Journal of Geophysical Research, 73, (March 15, 1968), nr. 6, pag. 1913-1919, 11 ref.. 8 fig., 1 tab.

A trailing wire antenna was used as a sensor for airborne measurements of weak atmospheric electric fields in the 60- to 3000-mv/m range. This technique provided ± 30-volt antenna signals from horizontal components of fields produced by fair weather spacecharge concentrations within the austausch layer. The average separation of charge centers was 536 meters. The maximum space-charge density detected was 6.3×10^{-11} colomb m^{-3}. The weak fields were found to be strongly dependent on direct solar input to the atmosphere and broadly distributed in both altitude and distance within the austausch layer only.

2.1.2 TDCK 80602 ELECTRICITY OF THE FREE ATMOSPHERE

Imganitov, I.M., Chubarina, Ye, V.

Foreign Technol. Div. (August 21, 1968), 261 pag., 45 fig., 72 tab., 117 ref.

This book is based on data obtained during the IGY by systematic aircraft soundings of the earth's electric field. More than 2000 soundings were made, and the results of data processing are analyzed in the book. In addition to the detailed information on the structure of the electric field in "good" weather, on the distribution of volumetric electric charges and potentials under these conditions. Also included are data on the electric structure of stratified clouds. Thus, the book presents a general picture of the electric structure of the atmosphere on cloudy and clear days. It is intended for specialists in the field of atmospheric, as well as the specialists inall those fields which are concerned with the phenomena of atmospheric electricity.

Electrics of fine weather

2.1.3 TDCK 55825 ATMOSPHERIC POTENTIAL-GRADIENT MEASUREMENTS AT SEA

S.G. Gathman Eva Mea Trent

Naval Research Lab. Wash. D.C., (24 feb. 1970), nr. Report 7030, pag. 22, 14 fig., 13 ref.

Shipboard measurements of atmospheric potentiol gradient are discussed. A comparison is made at sea between the performance of a potential-measuring apparatus and a field mill. The design of electometer input multistage voltage followers is presented as a solution to the degradation of insulators by the salt environment. A model is given which calculates from the ship's engine power and the relative wind vector the potential gradient due to the charged stack gas. A method is also described by which a reduction factor can be calculated so that the geometric distortion of a ship's superstructure is accounted for in potential-gradient measurements.

---

apparaat voor het meten van lucht-ionisering

2.1.4 E 7711 DAS IONOMETER, EIN GERÄT ZUR MESSUNG DER LUFTIONISIERUNG

Eichmeier, J., Loidiller, M.

Elektronik, 18, (September 1969), nr. 9, pag. 265-266, 3 fig., 7 ref.

In diesem Beitrag wird das Prinzip zur Messung von Luftionisierung beschrieben, und der Aufbau des Ionometers gezeigt.

Electrics of fine weather

2.1.5 TDCK 50227 ATMOSPHERIC ELECTRIC CHARACTERISTICS OF REGIONS

Kraakevik J.H. and Hoppel W.A.

Naval Research Laboratory, Washington, D.C. 20390,
(December 26, 1967), 16 pag., 2 tab., 7 fig., 12 ref.

Measurements of both polar conductivities, the electric field, mobility, density of small ions, and other related atmospheric variables were made from an airplane between 30 m and 6 km on two different series of flights separated by six years. Twenty-two soundings made in 1955-56 show that the general electrical characteristics can be classified by geographical regions. The variations of conductivity with altitude in the Arctic is shown to agree well with theory, if the value of mobility obtained in a 1962 series is used. A comparison of the two series indicates that the conductivity above the exchange layer and the mechanism by which the atmospheric potential is maintained was nearly the same on the average, during both series of measurements.

2.1.6 M 33299 THE ELECTRICAL CONDUCTIVITY OF OCEANIC AIR AND ITS CORRELATION TO GLOBAL ATMOSPHERIC POLLUTION

Cobb, William E., Wells, Howard, J.

Journal of the Atmospheric Sciences, 27, (August 1970), nr. 5, pag. 814-819, 3 fig., 26 ref.

The atmospheric electrical conductivity was recorded during the 1967 global expedition of the research vessel Oceanographer. Seventy-five complete days of fair weather conductivity observations were obtained and compared to earlier observations of the Carnegie Institution and others. Significant results show that the atmospheric conductivity in the remote South Pacific has remained fairly constant over the past half century but has decreased by at least 20% in the North Atlantic. The secular conductivity decrease in the North Atlantic is attributed to an increase in the fine-particle aerosol pollution suspended in the atmosphere of the Northern Hemisphere. The influence of atmospheric aerosols, primarily in the form of condensation nuclei, on the conductivity is discussed.

2.2 Electrics in clouds and thunderstorms

2.2.1 M 32989 ELECT IC FIELDS AND CONDUCTIVITY IN THUNDERCLOUDS

Evans, W.H.

Journal of Geophysical Research, 74, (February 1969), nr. 4, pag. 939-948, 9 fig., 6 ref.

In the summer thunderstorm season of 1967, thirty-two rotating-differential electric field mills were parchuted into incipient thunderclouds around Tucson, Arizona. Sixteen of these instruments recorded useful results over the telemetry channel. They were delivered as near the top and center of the cloud as possible by an aircraft and pilot from the National Center for Atmospheric Research. The initial conclusions are: (1) The electrical conductivity in thunderclouds is considerably higher than the outside conductivity at the same level, approximately by a factor of 10. (2) The magnitude of the electrical fields is smaller than the generally accepted values, by a factor of from 2 to 5. Because of the small number of data, the conclusions are highly tentative. However, the two conclusions are consistent with each other, and the data have been taken with much better instruments than any previous data.

2.2.2 M 33466 THE ELECTRICAL SHIELDING LAYER AROUND CHARGED CLOUDS AND ITS ROLE IN THUNDERSTORM ELECTRICITY

Hoppel, W.A., Phillips, B.B.

Journal of the Atmospheric Sciences, 28, (October 1971), nr. 7, pag. 1258-1271, 12 fig., 28 ref.

The system of differential equations which governs the equilibrium charge distribution around a charged cloud located in an atmosphere with constant ionization is solved numerically for clouds with differing water content. The equations include the effects of ionic recombination, and the ionic conduction currents to cloud droplets. The results show that the electric field external to the cloud is greatly reduced by a shielding charge distribution which first develops at the clear air-cloud boundary and then slowly moves inward toward the charge center. If ions are generated locally within the cloud, they produce an inner region of charged droplets of opposite polarity to the outer screening layer. An increased electric field maximum will exist between the regions of charge.

Electrics in clouds and thunderstorms

2.2.3 TDCK 059112 STUDIEN ZUR GEWITTERELEKTRIZITÄT

Mühleisen, R.; Fischer, H.J.

Astron. Institut der Universität, Tübingen,
(Dezember 1968), 66 pag., 38 fig., 24 ref.

Es war die Aufgabe gestellt, zu untersuchen, welche Zusammenhänge zwischen dem Aufbau und dem Ausgleich elektrischer Raumladungen in einer Gewitterzelle einerseits und den am Boden meszbaren luftelektrischen Grösze anderseits bestehen. Dazu werden zunächst die Ergebnisse der Messungen des statischen Grundfeldes, der statischen Feldsprünge und des Spitzenstroms in Nahbereich einer Gewitterzelle mitgeteilt, wobei die gewonnenen Daten auf ihren Aussagewert über die Ladungsverhältnisse in der Gewitterwolke und die Art und Form der Entladungen hin untersucht wurden. Zum anderen werden die Ergebnisse der Registrierungen der von den Blitzentladungen ausgehenden elektromagnetischen Spherics wiedergegeben und auf ihren Informationsgehalt bezüglich der Zahl, der Entfernung und der Aktivität von Gewitterzellen geprüft. Im letzten Kapitel werden die meteorologischen Voraussetzungen und zeitlichen Variationen der am Weiszenauer Institut beobachteten Gewitter behandelt.

2.2.4 M 33091 CHARGE DISTRIBUTION IN THUNDERSTORM CLOUDS

Ogawa, T. and Brook, M.

Quarterly Journal of the Royal Meteorological Society, vol.95, (June 1969), nr. 405, pag. 513-525, 13 fig., 13 ref.

The negative charge involved in lightning flashes to ground is found to be distributed in a manner strongly dependent upon the direction of movement of the storm, and does not, in general, constitute a nearly vertical column as proposed by Malan and Schonland. Based on a study of electric field-changes measured at two stations 10 km. apart involving 539 return strokes from 84 flashes in 10 storms, we conclude that the horizontal component of the in-cloud channel on the average exceeds the vertical component, and points in the direction of storm motion.

Electrics in clouds and thunderstorms

An analysis is given of the five methods of Malan and Schonland, on the basis of which we suggest that significant horizontal components are also compatible with their observations of a vertical column, and that the 'nearly vertical' aspect of the charge distribution has been over-emphasized.

2.2.5 M 33254 DIE BEDEUTUNG DES NIEDERSCHLAGES FUR DIE GEWITTER-ELEKTRIZITET

Israël, H.

Meteorol. Rundschau, 23, (July-August 1970), nr. 4, pag. 123-127, 5 fig., 1 tab., 19 ref.

Die Erfahrung zeigt, dass die Gewitterelektrifizierung in unmittelbarem Zusammenhang mit der Bildung und Bewegung von Niederschlagsteilchen in den Wolken steht. Zur Erklärung werden die Grundlagen des Elektrifizierungsprozesses besprochen und die Entwicklung der Gewittertheorie seit ihrer ersten Fassung durch Sohnke dargestellt. In schliessend werden neueren Untersuchungen über den quantitativen Zusammenhang zwischen der durch die Zeitliche Entladungsdichte definierte "Aktivität" eines Gewitters und der in ihrem "arbeitenden" Niederschlagsmenge besprochen.

2.2.6 M 23615 CONVECTED CHARGE IN THUNDERSTORMS

Phillips, B.B.

Monthly Weather Review, 95, (December 1967), nr. 12, pag. 863-870, 24 ref., 3 fig.

The charge transport within thunderclouds by the convective motions of the cloud is examined. In the presence of the primary positive dipole, shielding charge distributions are formed within the lower and upper cloud boundaries as the result of ion conduction from the free air and ion capture by droplets and precipitation in peripheral cloud layers. Cloud droplets positively charged by the conduction current to the cloud base are lifted by the updraft into upper cloud volumes where they contribute to the positive pole of the primary dipole. In turn, precipitation developing in the cloud top carries

negative charge to lower cloud levels during fall under gravity forces. The role of water accumulation in the upper cloud is shown to be an important factor in establishing the non-neutralizing current paths in upper cloud layers.
The charge transport by the convection mechanism is believed to be a major current flow of storms. The role of other thunderstorm electrification mechanisms is only briefly considered.

2.2.7 M 33167 THE INFERENCE OF THE CHARGE DISTRIBUTION IN THUNDERSTORMS FROM AIRBORNE MEASUREMENTS OF THE ELECTRIC FIELD

Schuman, E.L.

Journal of Applied Meteorology, vol.8, (October 1969), nr. 5, pag. 820-824, 5 fig., 5 ref.

A computer-oriented numerical method is developed that under certain physically acceptable assumptions appears to make possible the calculation of the charge distribution in thunderstorms and other clouds from the record of the electric field measured from an airplane that flies a known straight path near the cloud. The method is illustrated with an assumed charge distribution, and its application to actual flight measurements is cited.

2.2.8 AD667 417 SOME RESULTS OF TESTS ON THUNDERSTORM DETECTORS WITH A SMALL RANGE OF COVERAGE

Semenov, K.A.

American Meteorological Society, Boston Massachusetts (1964), 14 pag., 2 fig., 8 tab., 13 ref.

Experimental data on thunderstorm discharges recorded within a radius of 10 - 20 km by instruments with a variety of designs are compared and analyzed in the present paper.

Electrics in clouds and thunderstorms

2.2.9 M 33253 BESTIMMUNG DER ZAHL, ENTFERNUNG UND AKTIVITÄT VON GEWITTERZELLEN AUS REGISTRIERUNGEN DER SPHERIC-HÄUFIGKEIT

Mühleisen, R., Takeuti, T., Fischer, H.J.

Meteorol. Rundschau, (Juli/August 1970), nr. 4, pag. 11-113, 4 fig., 1 tab., 2 ref.

Nach der Beschreibung der von uns verwendeten Anlage zur Registrierung der Spheric-Häufigkeit im 3kHz-Bereich wird eine Methode der Reichweitenbestimmung derartiger Sfericzähler angegeben und die Ergibnisse diskutiert. Danach lassen sich aus der Häufigkeit von Spherics mit Amplitu den $>0{,}24$ V/m und >1 V/m gewisse Rückschlüsse auf die Anzahl der Gewitterzellen im Umkreis von 730 bzw. 250 km ziehen. Dabei tritt jedoch ein Widerspruch zur normalen Beziehung zwischen Feldstärke und Entfernung auf, zu dessen Erklärung angenommen wird, dass Gewitter über dem Alpenraum wesentlich mehr Erdblitze produzieren als über dem flachen Land.

2.2.10 M 33390 ON THE POWER SPECTRUM AND MECHANISM OF THUNDER

Holmes, C.R., and others

Journal of Geophysical Research, vol.76, (March 20, 1971), nr. 9, pag. 2106-2115, 8 fig., 3 tab., 13 ref.

Forty thunder events from intracloud and cloud-to-ground lightning were analyzed by analog and digital power spectrum methods. Thunder exhibits a low Q (0.5 to 2) spectrum with peak power observed at frequencies from 4 to 125 Hz. Significant differences are noted between thunder from intracloud and cloud-to-ground lightning. Intracloud thunder spectrums show a mean peak value of power at 28 Hz with a mean total acoustic energy of 1.9×10^{13} ergs. Cloud-to-ground spectrums show a mean peak value at 50 Hz with a mean total acoustic energy of 6.3×10^{13} ergs. The mean total acoustic efficiency for discharges to ground is calculated to be 0.18%. The thunder power spectrum is time varying.

Electrics in clouds and thunderstorms

2.2.11 TDCK 52274 METEOROLOGISCHE ABHANDLUNGEN BAND 74, HEFT 2: DAS GEWITTER UND SEINE THEORIEN

Böhrenz, H.

Institut für Meteorologie und Geophysik der Freien Universität Berlin, (1967), 72 pag., 12 fig., 186 ref.

Es werden die wolkenphysikatischen Randbedingungen für den Aufbau des elektrischen Feldes, das zu Blitzentladungen führt, aufgezeigt. Wenn auch die in allen ihren Auswirkungen abgehandelten Gewitterzirkulationen nach den eindeutigen Messergebnissen gut verstanden werden, ist der Fragenkomplex hinsichtlich der elektrischen Erscheinungen noch ungelöst. Auf Grund der Forschungsergebnisse von R. Scherhag und der Weltgewitterstatistik der world meteorological organization ist das Gewitter in das weltweite meteorologische Geschehen worden.

2.2.12 M 23553 THE ROLE OF PARTICLE INTERACTIONS IN THE DISTRIBUTION OF ELECTRICITY IN THUNDERSTORMS

Sartor, J.D.

Journal of the Atmospheric Sciences, 24, (November 1967), nr. 6, pag. 601-615, 9 fig., 6 tab., 55 ref.

The growth of electric fields in clouds resulting from charge rearrangement due to particle interaction and translation is calculated under the assumption that the initial electrification is provided by the fair weather charge distribution of the atmosphere or by some other basic charge separating process. The results demonstrate that particle interaction must be taken into account in the electrification process during the precipitation formation period. In fact, they show that, starting with the normal fair weather field, it is possible to explain qualitively and quantitatively many of the presently known observations of the electrical growth and field recovery behavior of thunderstorms.

Electrics in clouds and thunderstorms

2.2.13 M 33292 MECHANISM OF CHARGE DRAINAGE FROM THE THUNDERSTORM CLOUDS

Loeb, Leonard, B.

Journal of geophysical research (October, 20 1970), vol.75, nr. 34, pag. 5882-5889, 27 ref.

A solution to the problem of cloud drainage leading to lightning strokes that involve the corona streamer mechanism raindrop-leader clouds had never been delineated in detail. Recent studies, especially the work of G.A. Dawson on the disruption and discharge from reaindrop-size water droplets, have now permitted the completion of the picture by giving a basis for the early and rapid generation of the high fields near the cloud base initiating the stepped leader and permitting the drainage to proceed as the leader forges its way to ground.

2.2.14 TDCK 61444 ELECTRICITY OF CLOUDS

Imyanitov, I.M., Chubarina, V., and Shvarts, Y.M.

NASA (June 1972), nr. T72-07454, 122 pag., many fig., many tab., many diagr., 181 ref.

The electricity of the clouds substantially affects their evolution, particularly the development of thunderstorms and the formation of precipitation. The probability of lightning hitting aircraft and the reliability of the aircraft's radio communication and navigation devices are closely connected with the electricity of the clouds. In the Brobdingnagian scale of the atmosphere, as compared with the Lilliputian scale of the laboratories, our ideas developed indoors of what is possible and what isn't begin to lose sense. The case of ball lightning can be cited as an example. At the same time, meteorologists know very little about the electrical properties of the clouds, their "electrical nature", especially modern ideas and data are not yet published in the widely spread literature.

Electrics in clouds and thunderstorms

2.2.15 M 33688 INFRASONIC THUNDER

Dessler, A.J.

Journal of Geophysical Research, 78, (April 1973), nr. 12, pag. 1889-1896, 3 fig., 19 ref.

An electrostatic mechanism for the generation of thunder, originally suggested by Wilson (1920), is applied to a model of thundercloud in which the charge needed to produce a lightning flash is drained from within the cloud, either from a relatively thin horizontal layer or from a cylindrical volume. The mutual repulsion of the charged water droplets causes the atmospheric pressure to be reduced within the charged regions of the cloud. An acoustic rarefaction pulse is generated following a lightning discharge as atmospheric pressure equiliorium tends to be restored in the region from which charge is removed.

2.2.16 M 33140 RESEARCH INTO ELECTRICITY IN CLOUDS

Imjanitov, I.M., and Schwarz, M.J.

W.M.O. Bulletin, XVIII, (October 1969), nr. 4, pag. 221-230, 5 fig., 1 tab., 20 ref.

Research into electricity in clouds, which is clearly moving forward with increasing speed, is stimulated by many problems which face meteorologists and other specialists. Let us pick out two groups of such tasks. First there is the group linked directly to the study of electricity in the atmosphere. This involves such problems as elucidating the mechanisms by which cloud particles or whole clouds are electrified, and the part played by clouds in the formation of local and general electrical characteristics of the atmosphere. A second group of tasks is connected with research into the physics of clouds, relate to the possibility of actively influencing processes which to go on in clouds.

Electrics in clouds and thunderstorms

2.2.17 M32643 ELECTRIFICATION ACCOMPANYING THE MELTING OF ICE PATICLES

Drake, J.G.

Quarterly Journal of the Royal Meteorological Society, 94, (April 1968), nr. 400, pag. 176-191, 15 ref., 13 fig.

It was observed that during the melting of small ice particles supported in a vertical wind tunnel, strong convection currents developed in the melt water. Bubbles released from the ice during melting were swept up by the currents and rapidly transferred to the surface where they burst. The separation of electric charge accompanying the bursting of the bubbles was highly dependent on the convection currents in the water. The observed charging effects are not entirely consistent with theories based on the disruption of an electric double layer. In particular, the separation of charge is considerably increased if the air contains high concentrations of CO_2. It is shown that the observed values of charge separation are sufficient to account completely for the presence of the lower pocket of positive charge found below the melting level in many thunderstorms.

2.2.18 M 33754 NUMERICAL SIMULATION OF ATMOSPHERIC ELECTRICITY EFFECTS IN A CLOUD MODEL

Pringle, J.E.; et al.

Journal of Geophysical Research, 78, (July 20, 1973), nr. 21, pag. 4508-4514, 2 fig., 18 ref.

Results from a numerical model of cloud initiation, growth, and electrification are presented. The model is two-dimensional and the time dependent. The first and third equations of motion, a thermodynamic energy equation, and various water conservation equations along with conservation equations for 11 types of ions and neutral particles are solved numerically. The small ion equations (positive and negative ions) model drift velocities, advection, point discharge near the ground, generation due to cosimc radiation, loss due to recombination, and loss or gain due to attachment or detachment of the ions to or from cloud and rain particles. The large ions and neutral particle equations are modeled in the same manner as the small ions but without drift velocities, production due to cosmic radiation or point discharge.

Electrics in clouds and thunderstorms

The cloud and rain ions are treated in the same manner as the particles to which they are attached. Positive ions are arbitrarily attached to cloud particles, and negative ions to rain particles to simulate the observations of net positive charge on cloud, net negative charge on rain.

2.3 LIGHTNING

2.3.1. NR 58514 SHOCK WAVE FROM A LIGHTNING DISCHARGE

Jones, D.L.

Journal of Geophysical Research, 73, (May 15, 1968), nr. 10, pag. 3121-3127, 2 fig., 26 ref.

A theoretical model of the shock wave from a lightning discharge ranging from the strong blast wave region out to the acoustic limit is given for the first time. The trajectory and overpressure of the strong shock wave are described by the well-known equations for cylindrical blast waves. In the intermediate shock strength region ($1.1 < M < 3.3$), the shock trajectory is given by the "correct limit" equation of Vlases and Jones. We derive an additional "correct limit" equation for overpressure that is valid out to the acoustic limit. The correct limit equations predict a much slower decay of the intermediate shock wave; thus, the shock wave is much stronger at large distances from the discharge than was previously believed. Consequently, the range of action of the lightning discharge via its shock wave, as it affects the shattering and freezing of supercooled hydrometeors, may be large.

2.3.2 K 39786 THE BRITISH CODE OF PRACTICE ON "THE PROTECTION OF STRUCTURES AGAINST LIGHTNING"

Golde, R.H.

Elektrotechnische Zeitschrift, 92, (September 1971), nr. 9, Ausgabe A, pag. 516-520, 2 fig., 1 tab., 8 ref.

LIGHTNING

The British Code constitutes a set of recommendations which are incorporated, where appropriate, in certain governmental regulations or standard specifications. The aspect described cover some of those questions on which differing views are expressed in different national recommendations, such as the zone of protection of a lightning conductor, the bonding or isolation of extensive metal components, the treatment of fences and trees and the protection of danger structures. A method is described for assessing the need of protection.

---

bescherming tegen bliksem voor personen

2.3.3 E 9318 BLITZFORSCHUNG UND PERSONEN-BLITZSCHUTZ

Berger, K.

Elektrotechnische Zeitschrift -A, 92, (1971), nr. 9, pag. 508-511, 2 fig., 8 ref.

Im ersten Teil der Arbeit werden die Ergebnisse der statistischen Auswertung der Blitzmessungen auf dem Monte San Salvatore bei Lugano während der Jahre 1963 bis 1970 bekanntgegeben. Dabei sind ausschliesslich die Abwärtsblitze berücksichtigt, d.h. jene Blitze, die aus den Wolken zur Erde herunterwachsen und die somit auf den Bergen und im Tiefland in gleicher Weise zu erwarten sind.
Im zweiten Teil der Arbeit werden die Möglichkeiten des Blitzschutzes jener Personen besprochen, die sich bei Gewitter längere Zeit im Freien aufhalten und denen kein Schutzraum zur Verfügung steht. Neben dem idealen Faraday-Käfig bestehen weniger vollkommene Schutzmassnahmen, bei denen beim direkten Blitzeinschlag wohl mit einem mehr oder weniger deutlich spürbaren elektrischen Schlag zu rechnen ist, die aber im Stande sind, das gefürchtete Herzflimmern zu verhindern.

LIGHTNING

bliksem-storingen in vliegtuigen

2.3.4 TDCK 81993 MEASUREMENTS AND ANALYSIS OF LIGHTNING INDUCED VOLTAGES IN AIRCRAFT ELECTRICAL SYSTEMS

Hacker, P.T., Plumer J.A.

1970 Lightning and static electricity conference, San Diego, California, USA, (9-11 December 1970), nr. TM X-52906, 28 pag., 19 fig., 7 tab., 13 ref.

A series of measurements were made of voltages induced in electrical circuits within a metallic aircraft wing by full-scale simulated lightning currents flowing through its skin and structure The measured data were mathematically analyzed to enable determination of voltages across load impedances to which the circuits might be connected elsewhere in the aircraft. Relationships between induced voltages and lightning current, wing structural and circuit parameters were to cause damage or interference with avionics were measured.

---

onweersvoorspelling

2.3.5 E 9762 RADAR AND COMPUTER PREDICT LIGHTNING

Electronics, (May 1972), nr. 5, 1 pag., 1 fig.

The Tokyo Electric Power Co. is trying to minimize the effects of summer thunderstorms. On the top of the headquarters building the company builded a tower. A weather radar, as well as a microwave gear stop tower is installed. The radar feeds into a hybrid, analog-digital computer, which autometically determines when radar returns indicate the presence of thunder clouds in a radius of about 2,3 km.

LIGHTNING

2.3.6 TDCK 56017 LIGHTNING AND ROCKETS: SOME IMPLICATIONS OF APOLLO 12 LIGHTNING EVENT

Brook, M., Holmes, C.R., Moore, C.B.

Naval Research Reviews, (April 1970), pag. 17, 3 fig., 3 tab., 3 ref.

Analyses van de 2 gevallen van blikseminslag op de Apollo 12 tijdens de lancering.

2.3.7 P 59.489 PROTECTION OF STRUCTURES AGAINST LIGHTNING

Golde, R.H.

Proceedings of the Institution of Electrical Engineers, 115, (October 1968), nr. 10, pag. 1523-1529, 1 fig., 1 diagr., 21 ref.

In contrast to earlier revisions of the original Code of Practice, CPI 1943, the latest revision, published in 1965, introduces several important additions and modifications, based on new concepts of lightning protection and taking account of modern building methods and materials. The paper discusses these modifications and the reasons for their introduction.

2.3.8 M 23744 WHAT YOU SHOULD KNOW ABOUT LIGHTNING

The Mac Flyer, Military Airlift Command, 15, (May 1968), nr. 5, pag. 4-9, 3 fig.

After a short explanation of the nature and course of lightning, a survey is given of lightning variations as ball lightning, cloud to cloud flashes etc. etc.
Explained is why lightning strikes an aircraft and which parts will be hit.
Instructions for pilots are mentioned to avoid lightning.

LIGHTNING

2.3.9 M 23763 A NOTE ON LIGHTNING STRIKES TO AIRCRAFT

Cobb, W.E. Holitna, F.J.

Monthly Weather Review, 96, (November 1968), nr. 11, pag. 807-808, 1 tab., 6 ref.

A DC-6 research aircraft was struck by lightning on three occasions during a thunderstorm research project at Flagstaff, Ariz., in July 1967. Electric fields and meteorological parameters were measured and recorded. Similar conditions existed at the time of the lightning strikes. Each event occured in a dissipating cumulonibus, near the freezing level and in a region containing both ice and water. Corona discharge from the aircraft occured prior to each strike. The possibility exists that one or more of the lightning strikes were triggered by the aircraft.

2.3.10 TDCK 83143 A COMPARISON OF NATURAL LIGHTNING AND THE LONG LABORATORY SPARK WITH APPLICATION TO LIGHTNING TESTING

Uman, M.A., et al.

Westinghouse Research Laboratories, Pittsburgh, (August 1970), nr. NA-69-27, 73 pag., 57 fig., 2 tab., many ref.

Laboratory sparks a few meters in length can be used to simulate lightning current rates-of-rise and peak values and to simulate some of the temporal characteristics of the lightning channel temperature. Long spark generators are inadequate for producing a simulation of the continuing current phase of lightning. Long sparks cannot be used to produce a simulation of the shock wave due to lightning except in that the spark data can be scaled by theory to predict the characteristics of the lightning shock wave. A short discussion is given of the several types of lightning which might be encountered by an aircraft. The validity of long-spark testing in determining the likely points of strike of a lightning discharge to an aircraft or other structure is briefly considered.

LIGHTNING

2.3.11 M 33293 INITIATION OF CLOUD-TO-GROUND LIGHTNING STROKES

Dawson, G.A., and Duff, D.G.

Journal of Geophysical Research (20 October 1970), vol.75, nr. 30, pag. 5858-5867, 3 fig., 2 tab., 22 ref.

Using a computer and postulating highly idealized thundercloud conditions, we have modeled the interaction between a population of raindrops and a region of high electric field. Under favorable circumstances, the interaction produced a downward-moving wave of potential gradient that intensified the preexising field without apparent limit. The two major parameters that determined the intensification were the raindrop concentration and the amount of immobile negative charge produced by a stressed raindrop. Field intensification seems to depend critically on the peculiar characteristics of a water-drop discharge at the altitude considered, namely the production of large numbers of highly charged negative droplets Charged raindrops alone could not produce the required effect. It is suggested that the mechanism modeled here could be responsible for the initiation of cloud-to-ground lightning strokes. The mechanism should strongly favor a downward-moving negative discharge.

2.3.12 M 33477 THUNDERBOLTS

Hill, R.D.

Endeavour, 31, (January 1971), nr. 112, pag. 3-9, 8 fig., 2 diagr., 8 ref.

As one of the most dramatic of natural phenomena, the nature of lightning has been a source of speculation since early times. Not until the eighteenth century, however, was it clearly identified as being of an electrical nature. In this review of recent work emphasis is laid on the characteristics of the lightning channel, which now appears to be a great deal narrower than had been supposed.

LIGHTNING

2.3.13 TDCK 80782 LIGHTNING ENVIRONMENTS

Gordon, W.F.

Sandia Laboratories, Livermore, California, (April 1969), SCL-DR-69 40, 38 pag., 18 fig., 5 tab., 14 ref.

This report contains a basic description of lightning phenomena to assist system designers in
a. understanding the over-all environment,
b. identifying design strengths and weaknesses from a susceptibility standpoint,
c. viewing potential design problems in proper perspective, and
d. logically deriving an evaluation program with which to determine system transfer functions and ultimately susceptibility.
The information is applicable to both safety and reliability design considerations. Lightning environments discussed include direct strikes to earth-based objects, direct strikes to airborne objects, and EMP from nearby strokes.

2.3.14 M 23617 PROBABLE AIRCRAFT "TRIGGERING" OF LIGHTNING IN CERTAIN THUNDERSTORMS

Fitzgerald, D.R.

Monthly Weather Review, 95, (December 1967), nr. 12, pag. 835-842, 5 ref. 7 fig., 2 tab.

Three aircraft have been used to study the lightning and related cloud physics properties of Florida thunderstorms. The average probability of a lightning strike to the storm penetration aircraft was 0.021, based on the ratio of aircraft strikes to total number of strikes during penetration periods. On 2 exceptional days, the probability increased to 1.00 and 0.50. These storms were found to be in early dissipating stage. The results appear to confirm the suggestion of L.P. Harrison that an aircraft may act to initiate streamers and lightning discharges by suddenly augmenting the field in a localized region in the storm. This effect is most likely to occur shortly after the storm activity has diminished to the point where natural streamer formation is difficult.

LIGHTNING

2.3.15 M 33071 WETTERERSCHEINUNGEN IN AUSSTRÖMENDER KALTLUFT

Horney, Dipl.-Met. Günther

Meteorologische Rundschau, 22, (Juli/August 1969), nr. 4, pag. 106-113, 15 fig., 4 ref.

Im geographisch stärker gegliederten Gelände treten in Strahlungsnächten häufig Kaltluftströme auf, die vom kerkömmlichen Bild des Kaltluftabflusses mehr oder weniger abweichen.
Diese Kaltluftströme sind oft von charakteristischen Wettererscheinungen begleitet. Uber einige solche Wettererscheinungen wird berichtet.

2.3.16 TDCK 82473 OBSERVATIONS OF RAIN AND HAIL GUSHES LIGHTING

Moore, C.B., et al.

Little (Arth.D.), Incorp. Cambridge, (April 22, 1963), nr. AD 713.225, 16 pag., 10 fig., 1 tab., 26 ref.

Observations of thunderstorms in New Mexico were made with a vertically-scanning, 3 cm radar on a mountain-top. Prior to a lightning stroke the radar echo was usually quite weak indicating precipitation echoes of 5 mm hr^{-1} or less. Following the lightning stroke it was observed that in the region of the cloud where the stroke took place the radar echo intensity rapidly increased and a gush of rain or hail fell nearby. In some cases after the lightning stroke there were regions in the cloud where the low radar reflectivity decreased instead of increased.
These measurements confirm earlier radar observations, made by the authors at Grand Bahama Island B.W.I., which showed that lightning strokes are often followed by the detection of a rapidly-intensifying echo and then by a gush of rain at the ground. The increases and decreases in radar reflectivity in small volumes of the cloud following lightning suggest that the electric discharge is influencing the nature of particles in the cloud.

LIGHTNING

2.3.17 M 23661 PRESSURE PULSE FROM A LIGHTNING STROKE

Hill, E.L., Robb, J.D.

Journal of Geophysical Research, 73, (March 15, 1968), nr. 6, pag. 1883, 26 ref.

Measurements of pressure pulses from triggered lightning strokes show that they are not the result of strong mechanical shock waves of the type postulated by Abramson et al. as the explanation of channel growth in spark breakdown. Physical arguments, which are applicable also to natural lightning strokes, indicate that the rate of thermal heating in the channel is too slow to allow the development of the required strong ionizing shock front.

2.3.18 TDCK 53976 AIRCRAFT FUEL VENT LINE SENSITIVITY TO LIGHTNING EFFECTS

Markels, M. Jr., and Spurlock, J.M., Robb, J.D. and Stahmann, J.R.

Society of Automotive Engineers, (April 21-24, 1969), nr. 690434, 14 pag., 8 fig., 4 tab., 13 ref.

Results of investigation to develop a technological basis for overcoming aircraft lightning-strike hazards associated with turbojet aircraft fuel vents are dicussed. Flame propagation and arrester experiments were performed with highvoltage and high-current facilities and repeated in a combustion research facilities using a drive tube to simulate impulse effects of natural lightning. Flame propagation through actual aircraft vent systems containing flammable fuel-air mixtures was demonstrated, and characteristics flame propagation properties were measured and duplicated in laboratory apparatus.

LIGHTNING

2.3.19 L 16914 NEW STUDIES EXPLORE LIGHTNING

Yaffee, M.L.

Aviation Week, 96, (January 31, 1972), nr. 5, pag. 51 t/m 56, 5 fig.

Hazards of aircraft strikes increase with growing use of composite materials and sensitive miniaturized avionics.
Extensive research under wey here at General Electric's High Voltage Laboratory is aimed at fuller understanding of lightning phenomena and their structural and electrical effects on aircraft.

2.3.20 TDCK 49835 THUNDERSTORM LIGHTNING

Miller, E.

Deputy for Flight Test Aeronautical Systems Division (4 August 1967), 7 pag., 20 fig., 1 tab., 3 ref.

The United States Air Force does not practice the policy of purposely flying aircraft through thunderstorm, in fact, the stated procedure is to avoid the thunderstorm whenever possible.
However, for the last Seven years, the Deputy for Flight Test, Aeronautical Systems Division (ASD) of the Air Force Systems Command has negated this rule for some tests which were labeled with the very appropriate name "Roughrider".
One of the aircraft, an F-100F has the dubious honor of averaging approximately 100 penetrations per year through thunderstorms in the Southcentral and Southern parts of the United States.

LIGHTNING

2.3.21 TDCK 58923 1970 LIGHTNING AND STATIC ELECTRICITY CONFERENCE, 9-11 DECEMBER

Many authors

Air Force Avionics Laboratory and Society of Automotive Engineers, (December 1970), nr. A-71-19926, 327 pag., many fig., many tab., many ref.

Information is presented on lightning and static electricity phenomena from the standpoint of their relation to, and interaction with, aerospace vehicles and ground complexes. Interactions and the effects of lightning and static electricity on electrical, electronic, structural, static discharger systems and fly-by-wire systems of aerospace systems are described. The information presented is considered to be of interest to scientists and engineers in the fields of electronics, advanced composite materials and structures, and atmospheric electrical phenomena.

2.3.22 L 16767 LIGHTNING STRIKES

Freier, G.D.

Naval Aviation News, (June 1971), pag. 36-39, 4 fig.

Although we have found no way to predict or prevent lightning strikes to aircraft understanding the nature of this phenomena is a beginning. The following summary of a workshop held at NAS Moffet Field Calif., in December 1970 under the auspices of Commander Fleet Air Wings Pacific and the Office of Naval Research gives some answers and provides some insight into the nature of lightning and its effects on aircraft.

LIGHTNING

2.3.23 L 16683 LIGHTNING DOES STRIKE TWICE

Editor

Aerospace Safety, 27, (January 1971), nr. 1, pag. 6-7, 2 fig.

A crew report of a USAF RF-4C Phantom which received extensive damage from two successive lightning strikes it got hit by.

2.3.24 TDCK 83795 LIGHTNING HAZARD TO AIRCRAFT

Appleman, H.S.

HQ Air Weather Service (MAC) U.S. Air Force, (April 1971), nr. AD 724 092, 10 pag., 5 fig., 8 ref.

This report presents the latest available information on lightning hazards to jet aircraft. Included are the temperature and altitude range where most strokes are encountered, a brief discussion of the type of damage likely to be incurred, and a somewhat more detailed look into the possibility of fuel-tank explosions due to lightning and electrostatic discharges. It appears that, while the possibility of such explosions is small, aircraft using JP-4 fuel are generally more vulnerable to this hazard than those using gasoline or kerosene. It is concluded from this and other hazards associated with JP-4 that jet passenger aircraft, at least, shouls use kerosene fuels where possible.

2.3.25 L 16990 THE EFFECT OF LIGHTNING ON MATERIALS

Ibbott, J.D.

Aircraft Engineering, 44, (April 1972), nr. 4, pag. 25-28, 7 fig., 16 ref.

LIGHTNING

After briefly considering the surface areas of aircraft for which lightning strikes are a major factor in the seledtion of constructional materials, a review is made of published information concerning the effects of lightning on these various materials. The materials are considered under three headings: metallic, non-conducting (e.g. glass-fibre-reinforced plastics). Simulated lightning current tests are the main source of information and the review is primarily concerned with the results of such tests. To aid assessment of the relevance of the test currents that have been used, an outline of the current characteristics of lightning discharges is also given.

---

blikseminslag/kabel

2.3.26 E 10334 LIGHTNING PERFORMANCE OF OVERHEAD LINES

Young, M.D.P.

The Royal Engineers Journal, LXXXVII, (march 1973), nr. 1, pag. 38-53, 10 fig., 7 tab.

There have been many advances in recent years in the study of the effects of lightning on overhead power lines, particularly for ehv transmission lines. The purpose of this paper is to present a broas review of the subject and to indicate a simple method of assessing the lightning performance of overhead lines as a corollary, means of reducing the number of lightning induced faults are highlighted.

2.3.27 M 33882 ELECTRIC RADIATION FIELDS OF LIGHTNING RETURN STROKES IN THREE ISOLATED FLORIDA THUNDERSTORMS

Yung Tao Lin; Uman, M.A.

Journal of Geophysical Research, 78, (20 November 1973), nr. 33, pag. 7911-7915, 4 fig., 1 tab., 16 ref.

Peak value and rise time distributions for the electric radiation fields produced by lightning strokes to ground in three isolated Florida thunderstorms are presented. For each storm the average peak radiation field for first strokes was only slightly greater than the average peak field for subsequent strokes. For the sample of three storms the average peak radiation field in a given storm was proportional to the number of subsequent strokes per flash in that storm.

LIGHTNING

2.3.28 N 33764 AN UNUSUAL LIGHTNING FLASH INITIATED BY AN UPWARD-PROPAGATING LEADER

Orville, R.E.; Berger, K.

Journal of Geophysical Reasearch, 78, (20 July 1973), nr. 21, pag. 4520-4525, 7 fig., 3 ref.

A lightning flash has been recorded that was initiated by an upward-propagating negatively charged stepped leader that followed a looping path and passed within 600 meters of the initiating tower. It continued for a horizontal distance of approximately 2 km before leaving the field of view of the camera. Current flowed for at least 100 msec with a peak current that did not exceed 1600 amp. The total charge transferred was approximately +30 to 40 coulombs.

2.3.29 M 33904 AN UNUSUAL PHOTOGRAPH OF AN AIR LIGHTNING DISCHARGE

Krider, E.P.

Weather, 29, (January 1974), nr. 1, pag. 24-27, 6 fig., 3 ref.

On 5 August 1972, an air lightning discharge was photographed over Tucson, Arizona, with an all-sky camera.
The discharge, shown on the cover, was one of about six which occurred in about 30 min near the end of approximately four hours of intense lightning activity.

---

kabel/bescherming tegen bliksem

2.3.30 E 10238 VERHALTEN VON KABELN MIT GESCHICHTETEM AUFBAU BEI STOSZSTRÖMEN

Meister, H. und Utz, W.

Technische Mitteilungen, P.T.T., (1969), nr. 1, pag. 30-37, 8 fig., 6 ref.

LIGHTNING

In Gebieten mit hoher Blitzgefährdung werden Kabel benötigt, bei denen hohe Stossströme im Mantel nur kleine längsspannungen bewirken. Der geschichtete Aufbau eines Kabelmantels, unter Verwendung ferromagnetischer Werkstoffe, erlaubt kleine Kopplungsimpedanzen des Mantels bei erträglichem Materialaufwand. Die Autoren zeigen einen Weg zur näherungsweisen Berechnung dieser Kabel und beschreiben Ergebnisse von Messungen an ausgeführte Anlagen.

2.3.31 TDCK 85134 LIGHTNING AND STATIC ELECTRICITY CONFERENCE

Many authors

Air Force Avionics Laboratory, Wright-Patterson, A.F.B. Ohio, (December 1972), nr. AD 752551, 694 pag., may fig., many tab.

This document contains the text of unclassified papers presented at the 1972 Conference on Lightning and Static Electricity, held 12-15 December 1972. The papers document the discussion of the theoretical aspects of both lightning and atmospheric electrification. In addition, the practical control of adverse effects is addressed relative to aerospace vehicles and installations. Sessions include fundamental aspects, missiles and spacecraft, aircraft, advanced composites, fuels, and lightning simulation.

2.4 BALL LIGHTNING

2.4.1 M 33473 BALL LIGHTNING AS AN OPTICAL ILLUSION

Argyle, E.

Nature, vol.230, (19 March 1971), nr. 5290, pag. 179-180, 20 ref.

During the past year there have been numerous publications on ball lightning, many attempting to account for the formation, properties and behaviour of lightning balls. None have questioned the reality of the phenomenon, in spite of the lack of progress toward an understanding of these baffling objects.

BALL LIGHTNING

Serious doubt about the existance of ball lightning was expressed by Humphreys in 1936, and more recently by Schonland. Both regarded the phenomenon as probably an optical illusion. Now that Abschulcr et al. have invoked nuclear reactions to account for the lightning ball it seems appropriate to re-examine the possibility of finding an explanation in the physiology of vision.

2.4.2 M 33474 IS BALL LIGHTNING CAUSED BY ANTIMATTER METEORITES?

Ashby, D.E.T.F.

Nature, vol.230, (19 March 1971), nr. 5290, pag. 180-182, 2 fig., 23 ref.

Altschuler and others suggest that ball lightning arises from a concentration of short lived radioactive isotopes produced by lightning and imply a need for radiation measurements near thunderstorms and tornadoes. In this article the author reports measurements of this type which have been made for about 12 months to test the hypothesis that ball lightning is caused by the annihilation of minute fragments of meteoritic antimatter from the upper atmosphere.

2.4.3 TDCK 84827 LIG'TNING AND BALL LIGHTNING: FRONTIERS FOR RESEARCH

Cooper, J.A.

Sandia Laboratories, Albuquerque, (May 1971), nr. SC-R-22645, 39 pag., 20 fig., 35 ref.

During the past few years, interest in lightning and ball lightning has increased significantly. Information about these dramatic natural events affects or might affect various scientific areas including electrothermochemistry, magnetohydrodynamics, meteorology, safety engineering, and weapons strategy. Studies of lightning and ball lightning are made difficult by relative inaccessibility to experimentalists. However, there is a strong possibility that triggering mechanisms might be employed in studying these phenomena.

BALL LIGHTNING

2.4.4 M 33777 CAN BALL LIGHTNING EXIST IN A VACUUM?

Jennison, R.C.

Nature, 245, (September 14, 1973), nr. 5420, pag. 95, 4 ref.

I suggest that ball lightning is dependent not on the vaporization of a surface but on the formation of a phaselooked loop of electromagnetic radiation in the intense field associated with lightning activity. I further suggest that there is, in these circumstances, a particular wavelength of electromagnetic radiation which can form a stable standing wave which externally exhibits a spherical configuration and which excites the ambient gas to produce the glow by which it is seen. As the nergy is dissipated in this manner the lifetime of the ball is limited but the locking of the wavelength maintains its configuration and its dimensions. It follows that the typical clearance of the ball from conducting surfaces may be associated with the maintenance of equilibrium between the ball and its image in the conductor.

2.4.5 TDCK 84510 BALL LIGHTNING: NEW OBSERVATIONS AND NEW HYPOTHESES

Dmitriyev, M.T.

NASA, (September 1971), nr. TT F-13, 932, 25 pag., 5 fig., 1 tab., 10 ref.

In publishing new data about ball lightning on the pages of this journal, the editor attempts to attract attention to this phenomenon, which, up to the present time, has not had a generally accepted physical explanation. Difficulties of observation, theoretical interpretation and experimental reproduction of ball lightning must be completely and study in this direction, the editor will consider his task fulfilled.

BALL LIGHTNING

2.4.6 M 33589 THE ENIGMA OF BALL LIGHTNING

Charman, N.

New Scientist, 56, (14 December 1972), nr. 824, pag. 632 t/m 635, 4 fig.

Although it is an established phenomenon, the nature of ball lightning continues to baffle theoreticians. Ionisation, nuclear processes, confined plasmas, antimatter, ultra-high-frequency electromagnetic waves - even cosmis rays - have been invoked to explain these weird entities but the answers are still wide open.

2.5 AURORA

radar/ionosferische storingen

2.5.1 E 9880 VHF POWER SPECTRA OF THE RADAR AURORA

Balsley, B.B., and Ecklund, W.L.

Journal of Geophysical Research, 77, (September 1, 1972), nr. 25, pag. 4746-4760, 8 fig., 34 ref.

The power spectrum of a radar signal scattered from ionospheric irregularities has proven to be an invaliable tool for determining the mechanism(s) that operate(s) to produce the irregularities. Power spectra of VHF radar auroral echoes were obtained near Anchorage, Alaska, during October 15-23, 1970. These spectra were obtained concurrently with standard range-time-intensity (RTI) film strips of the schoing region using the same radar system. In this paper, these spectra and the RTI film strips are examined and are compared with previously defined radar auroral classifications.

AURORA

radar/ionosferische storingen

2.5.2 E 9936 CHATANIKA, ALASKA, AURORAL-ZONE INCOHERENT-SCATTER FACILITY

Leadabrand, R.L., Baron, M.J., Petriceks, J.

Radio Science, 7, (July 1972), nr. 7, pag. 747-758, 15 fig., 12 ref.

This paper announces the operational status of an auroral-zone incoherent-scatter radar. The Stanford Research Institute 1290-MHz incoherent-scatter radar, which was moved to Chatanika, Alaska (L = 5.7), an auroral-zone location near Fairbanks, is now producing interesting new results. The siting of the radar is such that D-, E-, and F region incoherent-scatter measurements can be made without ground-clutter interference. Although coherent auroral-clutter echoes can at times be seen at relstively low elevation angles in the north, auroral echoes are sufficiently weak at 1290 MHz in the sidelobes of the antenna that they are not detectable during normal incoherent-scatter measurements. The capabilities of the radar system are outlined, and samples are presented of the type of incoherent-scatter results being obtained.

2.5.3 TDCK 57335 DAS ZUSATZRAKETENPROGRAMM ZUM SATELLITENPROJEKT AZUR PROJEKT SPAZ. TEIL I: DIE WISSENSCHAFTLICHE NUTZLAST

Vele schrijvers

Bundesmin. f. Bildung und Wissenschaft, (November 1970), nr. BMBW FB W70-59, 168 pag., 61 fig., 14 tab. 61 ref.

Das als Ergänzung zu den mit dem Satelliten "AZUR" in der Polarlichtzone durchgeführten Messungen geplante, aus 5 Raketenstarts bestehende Zusatzraketenprogramm "SPAZ" wird beschrieben, insbesonders die in den einzelenen Nutzlasten enthalten Messinstrumente. Flugbahnen werden angegeben und geophysikalische Bodenregistrierungen während der Flüge zusammengestellt. Die Raketen wurden von Andøya/Norwegen aus gestartet.

AURORA

2.5.4 TDCK 57336 ZUSATZRAKETENPROGRAMM ZUM SATELLITENPROJEKT AZUR-625/A1-PROJEKT SPAZ. TL. II INTEGRATIONS- UND FLUG-BERICHT

Bunk, K., Jeanclaude, C., Kirchner, A., Scheuplein, A.

Bundesmin. f. Bildung und Wissenschaft, (November 1970), nr. BMBW-FB W70-60, 144 pag., 56 fig., 24 tab., 21 ref.

Der technischen Aufbau und die Herstellung von 5 RaketenNutzlasten für Black Brant V A-Raketen werden beschrieben. Test-Resultate, die an den Nutzlast-Spitzen gewonnen worden sind, werden dargestellt. Das Flugverhalten der Raketen wird an Hand von Betriebsüberwachungsdaten demonstriert.

2.5.5 M 33832 SIMULATIONS OBSERVATIONS OF AURORAS FROM THE SOUTH POLE STATION AND OF PRECIPITATING ELECTRONS BY ISIS 1

Winningham, J.D., et al.

Journal of Geophysical Research, 78, (1 October 1973), nr. 28, pag. 6579-6594, 11 fig., 18 ref.

On the basis of the simultaneous observations of auroras from the South Pole and of precipitating electrons by the Isis 1 satellite it is shown that (1) a midday auroral are (photographed on black and white film) occurs within the cleft (cusp) region projected to the appropriate auroral height along the geomagnetic field; (2) in the evening sector an aurora, observed by Isis 1 and the South Pole all-sky camera, extended for at least 5 hours of local geomagnetic time in the expected position of the auroral oval; and (3) during a period of extreme magnetic quiet, cleftlike electrons were observed just poleward of a narrow region of intense precipitation in the midnight sector.

---

3. ACOUSTIC PHENOMENA IN THE ATMOSPHERE

3.1 M 33149 ELECTROSTATIC SOUND IN CLOUDS AND LIGHTNING

S.A. Colgate and Ch. McKee

Journal of Geophysical Research, vol.74, (October 1969), nr. 23, pag. 5379-5389, 10 fig., 24 ref.

The sound pulse produced by the electrostatic stress of the cylindrical distribution of a lightning stepped leader (the predischarge, large-radius, nonequilibrium, electrostatic breakdown leader) has been calculated with a numerical computational program. The radial diffusion of the charge (Ionic mobility) in the electrostatic field occurs simultaneously with the radial propagation of the sound pulse. The magnitude of the resulting sound pulse is approximately 300 dynes/cm^2 after propagating 5 times the original stepped leader radius. The shock and sound pulse originating from the subsequent main stroke hot air channel has been similarly calculated and duplicates previous results of G.G. Goyer -law equation of state of air. The electrostatic sound pulse is roughly 1/300 of the subsequent main stroke, but, since it occurs earlier in time (10 to 100 msec), it should be detectable. The dominant frequency is roughly the same for the two sound pulses.

3.2 M 33478 COMBINED RADAR-ACOUSTIC SOUNDING SYSTEM

Marshall, J.M. et al.

Applied Optics, II, (January 1972), nr, 1, pag. 108-112, 4 fig., 1 tab., 9 ref.

Acoustic pulses at 85 Hz (4m) directed vertically into the lower atmosphere have been tracked by a 36.8-MHz (8-m) pulse doppler radar. Signal-to-noise power ratios in excess of 10 dB were obtained to a height of 1.5 km in the initial tests under conditions of calm winds. This technique has the potential of providing temperature soundings of the lower atmosphere for pollution studies and short-range terminal weather forecasts.

ACOUSTIC PHENOMENA IN THE ATMOSPHERE

3.3 M 33182 POWER SPECTRUM OF THUNDER

Few, A.A.

Journal of Geophysical Research, vol.74, (20 December 1969), nr. 28, pag. 6926-6934, 5 fig., 17 ref.

A model for the sound generated by a tortuous lightning channel is proposed that describes the principal features of thunder. The mode, indicates that the power spectrum of thunder should be similar to the power spectrum produced by a short line segment having the same energy-per-unit length Et as the most energetic return stroke in the lightning flash. This model also predicts that Et can be estimated from a measurement of the frequency of the peak in the power spectrum of thunder f_m; the relationship is $f_m = (0,63)Co(Po/Et)1/2$, where PO and C_0 are the ambient pressure and sound speed.

3.4 M 33688 INFRASONIC THUNDER

Dessler, A.J.

Journal of Geophysical Research, 78, (April 1973), nr. 12, pag. 1889-1896, 3 fig., 19 ref.

An electrostatic mechanism for the generation of thunder, originally suggested by Wilson (1920), is applied to a model of a thundercloud in which the charge needed to produce a lightning flash is drained from within the cloud, either from a relatively thin horizontal layer or form a cylindrical volume. The mutual repulsion of the charged water droplets causes the atmospheric pressure to be reduced within the charged regions of the cloud. An acoustic rarefaction pulse is generated following a lightning discharge as atmospheric pressure equilibrium tends to be restored in the region from which charge is removed.

ACOUSTIC PHENOMENA IN THE ATMOSPHERE

3.5 M 33726 DIURNAL VARIATION OF THUNDER AT MANCHESTER AIRPORT

Prichard, R.J.

Weather, 28, (August 1973), nr. 8, pag. 327-331, 3 tab., 6 ref.

In an earlier article Davis (1969) analysed the diurnal variation of thunder at Heathrow Airport, London, during the period July 1946 - June 1968. The results of a similar study at Manchester Airport (53° 21′N, 02° 16′W) are contained in this article and a comparison between the Manchester and Heathrow data is also included.

LIST OF AUTHORS

LIST OF AUTHORS

UDC: 551.593:551.594:551.596:016 TDCK Report No: 64275

Netherlands Armed Forces' Scientific and Technical Documentation and Information Centre, The Hague, 1974

SPECIAL METEOROLOGICAL PHENOMENA, A BIBLIOGRAPHY

by B.Ritsema, Tlt KLu., April 1974, 45 pag., 108 refs.

Contains about 85 abstracts of articles and Reports on special meteorological phenomena, published between jan. 1968 and march 1974.
There are three chapters: 1. Optical phenomena, 2. Electrical pehnomena and 3. Acoustic phenomena in the atmosphere. A list of authors has been included.

UDC: 551.593:551.594:551.596:016 TDCK Report No: 64275

Netherlands Armed Forces' Scientific and Technical Documentation and Information Centre, The Hague, 1974

SPECIAL METEOROLOGICAL PHENOMENA, A BIBLIOGRAPHY

by B.Ritsema, Tlt KLu., April 1974, 45 pag., 108 refs.

Contains about 85 abstracts of articles and Reports on special meteorological phenomena, published between jan. 1968 and march 1974.
There are three chapters: 1. Optical phenomena, 2. Electrical phenomena and 3. Acoustic phenomena in the atmosphere. A list of authors has been included.

UDC: 551.593:551.594:551.596:016 TDCK Report No: 64275

Netherlands Armed Forces' Scientific and Technical Documentation and Information Centre, The Hague, 1974

SPECIAL METEOROLOGICAL PHENOMENA, A BIBLIOGRAPHY

by B.Ritsema, Tlt KLu., April 1974, 45 pag., 108 refs.

Contains about 85 abstracts of articles and Reports on special meteorological phenomena, published between jan. 1968 and march 1974.
There are three chapters: 1. Optical phenomena, 2. Electrical phenomena and 3. Acoustic phenomena in the atmosphere. A list of authors has been included.

UDC: 551.593:551.594:551.596:016 TDCK Report No: 6.275

Netherlands Armed Forces' Scientific and Technical Documentation and Information Centre, The Hague, 1974

SPECIAL METEOROLOGICAL PHENOMENA, A BIBLIOGRAPHY

by B.Ritsema, Tlt KLu., April 1974, 45 pag., 108 refs.

Contains about 85 abstracts of articles and Reports on special meteorological phenomena, published between jan. 1968 and march 1974.
There are three chapters: 1. Optical phenomena, 2. Electrical phenomena and 3. Acoustic phenomena in the atmosphere. A list of authors has been included.

The Ambassador

Koninkrijk
der Nederlanden

Washington, October 23rd, 2009

Dear Mr Hamilton,

In reference you requested our review for release of your document nr. AD923359, entitled "Special Meteorological Phenomena, A Bibliography" to the public.

We reviewed the document and after consultation with the Netherlands Airforce Meteorological Group I hereby approve the release of the mentioned document to the public.

Yours sincerely,

Renée Jones-Bos

Mr Michael Hamilton
Action FOIA Program Manager
Defense Technical Information Center
8725 John J. Kingman Road, STE 0944
Ft. Belvoir, VA 22060-6218